



DEVELOPING WORLD WIND: UNDER CONSTRUCTION

Although Europe and North America remain the largest wind energy markets, the developing world is coming on strong, and many observers believe countries like India and China (with rapidly rising power demand and major pollution problems) have the biggest potential for rapid expansion.

In 1990, wind energy, at 20 megawatts of installed capacity, barely existed in China. At the end of 2003, China had 600 megawatts of wind power (putting it tenth on the list of largest wind producers), but much more was in development. In Guangting province, 60 miles from Beijing, *Wind* reports that one of the world's largest wind projects is underway and will generate 400 megawatts when it's completed.

China is the world's number one coal consumer, using it to generate 75 percent of its power. According to Yu Jie of Greenpeace China, pollution derived from that coal use is driving the new construction. "Acid rain blankets 70 percent of the country," he says. Air pollution, especially in China's 16 of the world's top 20 dirtiest cities, kills an estimated 400,000 Chinese a year.

China has nearly unlimited wind

resources, and could eventually harness as much as 600,000 megawatts, according to Corin Millais of the European Wind Energy Association. It may take some time to get there, but projects are sprouting. GE Wind Energy is supplying 10 of its 1.5-megawatt turbines for the 15-megawatt Huitengxile Wind Power Plant in Inner Mongolia. "We look forward to future opportunities to support China's goal to bring 20 gigawatts of new renewable energy capacity online by 2020," says Steve Zwolinski, president of GE's wind division.

Also in Inner Mongolia, in eastern China, Danish producer Vestas (which has 50 percent of the Chinese market) has installed 28 turbines generating 36 megawatts. Jens Olsen, Vestas' representative in China, comments that Chinese wind projects are developed and owned by the national power sector, but some private investment is permitted. He laments the lack of special credits for wind power but adds that the Kyoto Protocol might generate renewed foreign financing. "There is an increasing interest in wind power," Olsen says.

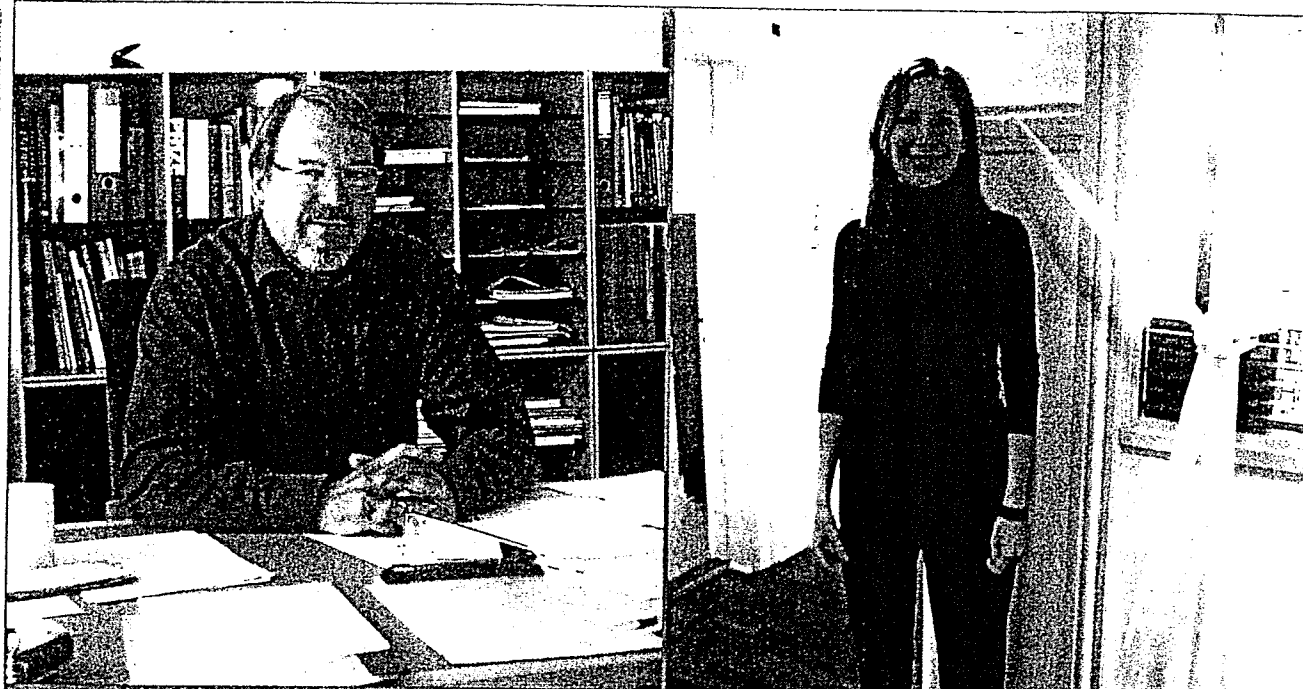
Two other companies, Greenwind Power Corporation and Optimal Ventures, are collaborating with China

Link Industries Group to build and operate a 50-megawatt wind farm on Daishan Island in Zhejiang Province. A large offshore wind farm, China's first, is underway with German investment in southern Guangdong Province, according to the *People's Daily*, with operation scheduled to commence in 2006.

India added 408 megawatts of wind power in 2003, and now has more than 2,000 megawatts of capacity (making it the world's fifth largest producer). India also has its own wind turbine company, Suzlon, which has installed some units in the U.S. and is looking to expand. Indian officials say 444 megawatts of new wind energy are under development in 28 projects. One such new project is the \$22 million, 25-megawatt plant planned by the Rajasthan State Power Corporation in the Jaisalmer district.

In other parts of the developing world, wind power is coming slowly to life. The first utility-scale wind project in Colombia is a 19-megawatt farm near the Caribbean coast on the peninsula of Guajira. Eastern Europe is also a fast-growing location for wind capacity, with new projects in Poland, Latvia, the Czech Republic, Estonia and Slovakia.

—J.M.E



Peter Helmer Steen (left), an associate energy minister, says more than 100,000 Danish families are members of wind co-ops. Hanne Jersild of the Danish Wind Energy Association hopes wind will meet 35 percent of the country's needs by 2015.

The wind farm includes 80 two-megawatt turbines, located 8.5 to 12 miles out in the North Sea, and from a beach littered with German World War II military bunkers it's an indistinct cluster of what appear to be toothpicks sticking out of the water. As Bill Eddy (who accompanied a Cape Cod delegation to Blavand) has observed, it "occupies only a small portion of the horizon, perhaps 20 degrees....Horns Reef is smaller than I thought."

Jan Toftdal of the Danish Tourist Board, who escorts visiting journalists around his picturesque region, admits that the wind farm was controversial when first proposed. The project went forward without much local input, he says, and there was some concern it would wreck the tourist-dependent economy.

"But now people are very accepting," says Toftdal, who has visited Cape Cod as a guest of Cape Wind supporters. "We have not seen one single tourist saying anything negative about it. There was recently a survey of people on the beach, and the most common response was 'What wind farm?' They just don't even see it."

The Cape-based Alliance has tried to spin this in another direction, touting the views of "economic expert" Chresten Andersen, who told Massachusetts audiences that it is "widely known" in Denmark that wind farms are undesirable neighbors. But that would appear to be contradicted by the facts on the ground in Blavand, where the tourist economy is booming and housing prices are rising.

In her office in downtown Copenhagen, decorated by a scale model of a Vestas turbine, Hanne Jersild of the Danish Wind Energy Association shakes her head when asked about declining property values. "There is simply no analysis to show an impact," she says. "When Horns Reef was built two years ago, there was talk about it, but the opposition has melted away." Now, she says, Horns Reef will be considerably expanded with another 200 megawatts of wind power within two years. Thanks in part to a "depowering" scheme that makes it advantageous to replace older, less-productive turbines with more efficient models, Denmark is likely to in-

crease its wind capacity so that it can meet 25 percent of the country's energy needs by 2008. The Wind Energy Association's goal is 35 percent of national needs by 2015.

In place of fear, there is now mostly optimism about this expanding industry, particularly in an environmentally conscious country where 20 percent of all travel is by bicycle. "The development of the wind industry here has been very rapid in the last 15 years," says Jersild. "China is a big potential market for us, and we have large markets already in Germany, Spain and Great Britain." Denmark is becoming something of a specialist in offshore wind development. "The marine environment is challenging, because of greater construction costs for the foundations, and wear and tear on the equipment, but offshore wind turbines are more productive," Jersild says. Thanks to more persistent wind, "an offshore turbine typically produces some 30 to 40 percent more energy per kilowatt than an onshore turbine."

Peter Helmer Steen is associate director of Energitryelsen, the Danish energy ministry, and he says the government has encouraged investment in wind research since the 1970s. The idea from the beginning, he says, was that local ownership of wind turbines should be encouraged, "so that you don't have windmills in Jutland owned by investors in Copenhagen. We recognized that people who are part-owners would be more willing to accept the noise and changes to the landscape." More than 100,000 Danish families are members of wind energy cooperatives, which have installed 86 percent of the country's turbines.

Denmark is an energy exporter, with the capacity to produce 170 percent of its domestic needs. It sells North Sea oil on the world market, surplus electricity to the Scandinavian countries (as much as 50 percent of production, says Steen) and natural gas to Sweden. Many of Denmark's existing power plants are coal-fired (with coal imported principally from South Africa), but the approximately 35 percent of the grid dependent on coal is offset by 27 percent from renewables (largely wind power, but also including biomass and

electricity from organic waste).

In addition to wind power, there are plants creating electricity from biomass and straw, and an efficient cogeneration system that distributes waste heat from power generation and incinerators to warm more than 300,000 homes in Copenhagen alone. Denmark hopes to reduce its greenhouse gas footprint 21 percent, in part through a carbon dioxide emissions trading system that begins this year. "Perhaps Denmark could be a model for the rest of the world in meeting the Kyoto climate goals," says Steen.

Can Denmark really meet 35 percent of its energy needs with wind by 2015? "It depends on how rapidly we develop commercial offshore wind farms," says Steen. "We want to see more competition for the contract to deliver large-scale, 250-megawatt wind farms. Production costs are decreasing rapidly [a 75 percent reduction between 1973 and 2003], so it may be feasible."

For his part, Vestas CEO Svend Sigaard says that for the last dozen years wind power has been surpassing the annual 20 percent growth rate internationally, achieving nearly 35 percent growth. He admits the U.S. market has been "quite low" because of the absence of tax credits, and that most current North American Vestas projects are in Canada. "The U.S. market over the last six years has been very on and off," Sigaard says, "and it's difficult to plan for the fluctuations in the regulations. But 2005 will be a better year for us in the U.S."

Vestas has had some setbacks at Horns Reef, due to manufacturing errors in transformers and other equipment (not built by Vestas) that have needed on-land repairs. "We've learned quite a lot from the experience," says Sigaard, who is cautiously optimistic about the 35-percent-by-2015 figure. "It's certainly possible, considering the ongoing replacement of our smaller turbines and the 1,000 megawatts in offshore projects that are under development," he says.

Not all of Denmark's offshore wind farms (it has eight) are in remote locations. The Middelgrunden project, capable of producing 100,000 megawatt-hours of electricity per year, is located just outside Copenhagen harbor, and consists of 20 two-megawatt turbines arrayed in a two-mile arc. Far from a visual blight, it's actually hard to see at all unless you find a rare high vantage point in this low-rise city. But when you finally do get a look at it, the white towers topped by gently spinning propeller-like blades present a visual picture of environmental progress.

Objecting to Wind

Like public transit, which is plagued by self-appointed "experts" who try and stop every proposed project, wind power

has opponents like Glenn Schleede, a former senior vice president of the National Coal Association. His mantra: Wind power equals huge machines producing very little electricity. Wind advocates, he says, greatly underestimate "the true cost of wind energy, as well as the adverse environmental, ecological, scenic and property value impacts."

But the American Wind Energy Association answers him point by point. "The cost of electricity from new wind plants is competitive with the cost of new conventional power plants, when the federal wind energy production tax credit is taken into account," the association says. "It is true that few wind plants would be built without this incentive. But it is also true that the traditional energy industries [including nuclear and coal] are generously subsidized in a variety of ways."

Do wind farms affect property values? Not according to a 2003 study by the Renewable Energy Policy Project (REPP). The group gathered a large database and examined more than 25,000 property transactions. "If there were any systematic harm to property values from wind power projects, it would

have shown up in the data," says REPP Research Director George Sterzinger. In the majority of transactions, property values actually rose in the period studied.

The libertarian Cato Institute complains that wind power is "not cheap and not green." It charges that renewable energy is, on average, twice as expensive as "the most economical fossil-fuel alternative," meaning dirty coal. But such estimates fail to take into account the cost of health effects caused by polluted air and global warming.

Another charge is that wind power is intermittent,

and therefore not as dependable as fossil-fuel energy. In California, says Cato, wind power operated at only 23 percent of its average capacity factor. Cato compares that to nuclear power, with a 75 percent average capacity factor. But to make wind energy appear inefficient it's necessary, again, to ignore the external costs of nuclear power production—including storing nuclear waste and protecting nuclear plants from 9/11-style attacks. Pacific Gas and Electric forecast in the early 1990s that wind could ultimately become the least-expensive electricity generation source. The cost of wind energy is also dropping faster than the cost of conventional generation, AWEA says, about 15 percent with each doubling of installed capacity worldwide.

Wind opponents, when they're not creating facsimiles of how bad offshore wind projects will look, point to the fact that birds collide with wind turbines. This is indeed tragic, but cell towers and other obstacles are a large part of the problem. A Western EcoSystems Technology report points out that as many as a billion birds are killed by collisions with man-made structures annually in the U.S. alone.



The wind farm at Altamont Pass in California was a pioneer in U.S. wind development, but it's in a migratory corridor and has raised concerns about bird mortality.

BY WARREN GRETZ/INTEL

Although as many as 40,000 birds die annually after hitting windmills, and that's a significant number, some 60 to 80 million die from colliding with vehicles, and as many as 980 million from hitting buildings and windows. Communications towers take out four to 50 million birds a year, and power lines kill many thousands more. The Exxon Valdez oil spill killed an estimated 375,000 to 500,000 birds. Further, newer, slow-moving turbines "are designed to provide little perching and no nesting structure," the report says, reducing bird proximity.

The Center for Biological Diversity says that wind turbines at the Altamont Pass Wind Resource Area (APWRA) in California, which is located on a major bird migratory route with high raptor density, "kill more birds of prey than any other wind facility in North America." Estimates range from 800 to 1,300 raptor deaths annually. But even the litigation-prone Center isn't proposing to shut Altamont down. Instead, it proposes that "turbine owners take reasonable measures to reduce bird kills and adequately compensate for impacts to imperiled bird populations."

Altamont was installed in the early 1980s, and wind developers have since become considerably more bird-friendly, designing less-lethal turbines using repellant devices and colors, and placing them away from migratory routes.

Also of concern is the issue of bat collisions with wind turbines, a phenomenon that has not received sufficient study. A 2003 report based on observations at the Buffalo Ridge Wind Resource Area in Minnesota (354 turbines operated by Xcel Energy) concluded that 849 bats were killed in 2001 and 364 in 2002, for an average of 2.16 per turbine per year.

Wind-Generated Hydrogen?

Can zero-emission wind power be used to produce hydrogen for fuel cells as part of a completely clean energy loop? There's some evidence that it can.

According to the Nuclear Information and Resource Service, the Bush administration's plans to use nuclear power to generate hydrogen are off base, and wind power presents a better option. "Electricity from wind is currently four cents per kilowatt-hour," the group says. "This is a verifiable, experi-

enced cost. Wind energy and photovoltaic systems coupled to electrolyzers used for hydrogen separation are perhaps the most versatile of the approaches and are likely to be the major hydrogen producers of the future." Princeton researcher Ioa Ogden, a booster of solar and wind-based hydrogen, adds that nuclear hydrogen is dependent on "difficult technology that is much further from commercialization than many other hydrogen-production options."

There are, however, certainly realistic obstacles to overcome before wind-based hydrogen can become a reality. A report by Science for Democratic Action concluded that "there are no real cost advantages to integrating fuel cells into the electricity system on a large scale." Bill Leighty, director of the Leighty Foundation in Juneau, Alaska, has some sobering second thoughts on the idea of transmitting large amounts of wind-generated electricity via a hydrogen pipeline from North Dakota, for example, to Chicago, a possibility examined in a study underwritten by his foundation.

"Hydrogen transmission does not appear to offer an economically attractive alternative to gigawatt-scale transmission of Great Plains wind energy via high-voltage [electric lines] because of the extra costs of conversion from electric to hydrogen energy at the Great Plains source," said a key sentence in Leighty's paper. "Capital, operations and maintenance, and energy conversion loss costs are significant, though energy storage as compressed hydrogen gas in the pipeline is a valuable benefit."

Leighty says wind-generated hydrogen is dependent on what the *Hydrogen and Fuel Cell Letter* describes as "the emergence of a large market for pure hydrogen...for [fuel-cell-based] transportation and for distributed generation."

But what if that market does develop? Claus Møller of the Danish Wind Energy Association says that the concept of hydrogen from wind is being actively pursued in Denmark, with small-scale demonstration projects and long-term feasibility studies underway in research institutes. If economics of scale come into play to dramatically reduce the cost of wind-powered hydrogen electrolyzers, reports a paper by Harry Braun of the Hydrogen Political Action

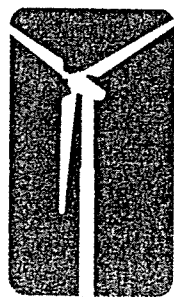
E WALKS THE TALK

E/The Environmental Magazine isn't just writing about wind power—we're actually buying it. Through a partnership with Renewable Choice Energy, we're offsetting 100 percent of our electricity use for the next three years through the purchase of wind energy certificates.

The plan is based on the fact that the grid combines both "clean" and "dirty" energy together into one big power supply. Here's how it works: we calculated our energy use (in a small office building in Connecticut and at our printer in Vermont) at 160,956 kilowatt-hours over the next three years, and then purchased wind certificates to make sure that much wind energy goes back in the grid.

Our wind offset amounts to 224,051 pounds of avoided carbon dioxide (CO₂) emissions annually, the equivalent of 244,597 miles not driven in an average car,

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WIND

or 20 cars effectively taken off the road. If you were to do this at home, you'd buy 600 kilowatt-hours of wind-generated power for \$15 a month, and get the same benefit as planting 140 trees. David Alexander of Boulder, Colorado says he decided to buy this form of green energy because "life is the sum of all our choices."

Renewable Choice Energy has signed agreements with affiliates of such major companies as Coldwell Banker, Sprint, Johnson & Johnson and Silk. soy milk explains CEO Quayle Hodge. One major buy came from Whole Foods, whose New Mexico and Colorado stores are purchasing 20 million kilowatt-hours of wind power annually, thus dodging 28,891,246

pounds of CO₂ pollution a year. They did it, we did it, you can do it, too! CONTACT: Renewable Choice Energy, (877) 810-8670, www.renewablechoice.com.

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Mega-projects like this wind farm in Palm Springs, California can reduce U.S. dependence on foreign oil. Environmentalist Lester Brown calls wind power "the missing link in the Bush energy plan."

Committee posted on *EV World*, then electricity could be generated at a cost of one cent per kilowatt-hour, resulting in liquid hydrogen produced for the same cost as gasoline at \$1.95 a gallon.

Braun calls for 12 million wind systems to be mass-produced and installed within 24 months and coupled to an interstate hydrogen pipeline. "It is possible for the U.S. to be energy independent, with a pollution-free and inexhaustible energy resource within five to 10 years," he says.

The Earth Policy Institute's Lester Brown offers a plausible scenario for wind-based hydrogen. "Surplus wind power can be stored as hydrogen and used in fuel cells or gas turbines to generate electricity, leveling supply when winds are variable," says Brown. "Wind, once seen as a cornerstone of the new energy economy, may turn out to be its foundation. The wind meteorologist who analyzes wind regimes and identifies the best sites for wind farms will play a role in the new energy economy comparable to that of the petroleum geologist in the old energy economy.

"With the advancing technologies for harnessing wind and powering motor vehicles with hydrogen, we can now see a future where farmers and ranchers can supply not only much of the country's electricity, but much of the hydrogen to fuel its fleet of automobiles as well. For the first time, the United States has the technology and resources to divorce itself from Middle Eastern oil."

An Unlimited Future

As the fastest-growing source of energy in the world, with the fewest long-term drawbacks, wind power would seem to have an unlimited future. Lester Brown describes wind power as "the missing link in the Bush energy plan." Bush has called for the addition of 393,000 megawatts of electric generating capacity by 2020, and he's proposed financial aid to businesses

that construct new nuclear power plants, as well as streamlined plant licensing. But no nuclear plant has been ordered in 30 years, and mammoth financial incentives may not be enough to offset the huge waste and liability questions.

But Bush's generating goals could be reached with wind power alone. Just three Great Plains states—North Dakota, Kansas and Texas—have enough wind potential to meet America's entire energy needs. Farmers and ranchers support wind projects because of the financial boon that comes with leasing their land. Wind projects completed just in 2003 will generate \$5 million annually in payments.

Wind energy designers are starting to think big. A project called Rolling Thunder, in South Dakota near the Iowa border, would generate 3,000 megawatts when it comes online in 2006, making it five times larger than any previous wind farm and one of the largest energy developments in the world today. At the same time, the federal Bonneville Power Administration (BPA) says it will buy 830 megawatts of wind power from seven plants—five to be built in Washington and two in Oregon. Already the nation's biggest supplier of hydroelectric power, BPA will be the largest wind energy supplier.

The pieces are in place for a massive expansion of wind resources worldwide at a time when concern about oil supply and location is proving to be massively troubling. All the signs are positive, but will wind power achieve its true potential? The answer, of course, is blowing in the wind. CONTACT: Alliance to Protect Nantucket Sound, (508)775-9767, www.saveoursound.org; American Wind Energy Association, (202) 383-2500, www.awea.org; Cape Wind Associates, (617)904-3100, www.capewind.org; Clean Power Now, (508)775-7796, www.cleanpowernow.org; Danish Wind Power Association, (011)45-3373-0330, www.windpower.org. **E**

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